NOTES
Shewing how to get the Angle
OF
PARALLAX
OF A
COMET,
Or other
PHÆNOMENON
At Two Obſervations,
To be taken in any One Station,
or Place of the Earth, and thereby
the diſtance from the Earth.

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TO THE
READER.

IN this I mean to be as brief as conveniently I may, intending only the practical part, therefore I set not down the Diagrams of Demonstration, which may be found in Authours, but referre to the places where they may be seen by such as think good to look upon them, only in the 13, and 14 Notes

C. A
Cal

methodus

I have set forth such Figures for Demonstration as are elswhere wanting. Moreover I advise the Reader to be prepared before hand with Trigonometrie, called also the Doctrine of Triangles, for without it nothing can be calculated, which is requisite in this desired Art.

Of

Of the Parallax

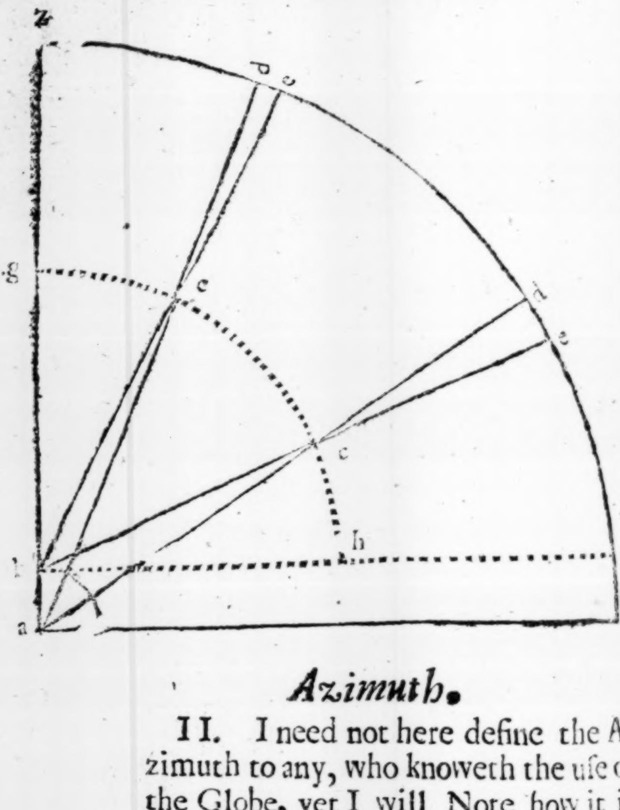
Definitions.

I. PArallax, that which I intend to speak of, and to find, is only the Angle *a*, *c*, *b*, contained between Two Lines, the one *a*,*c*, drawn from the Center of the Earth, the Other *b*, *c*. from the Superficies thereof, to the Center of a Comet or other Phænomenon, as in the Figure following.

But in an other sense, it is taken for an Arch of the Eight Sphereh, comprehended between the Lines *a*, *c*, and *b*, *c*, continued forth, and is called the Diversity of Aspects, such is the Arch *d*,*e*, in the Figure.

Note that the Parallax maketh the Phænomenon appear lower then indeed it is, and the higher that a Phænomenon is from the Horizon, the lesser is the Parallax thereof, and contra.

Azimuth,



Azimuth.

II. I need not here define the Azimuth to any, who knoweth the use of the Globe, yet I will Note how it is accounted in this case. Azimuth is an Arch of the Horizon contained between the North or South points of the Horizon, where the Meridian cutteth it, and a Vertical Circle, which falleth on the Horizon from the Zenith through the Center of any Starr.

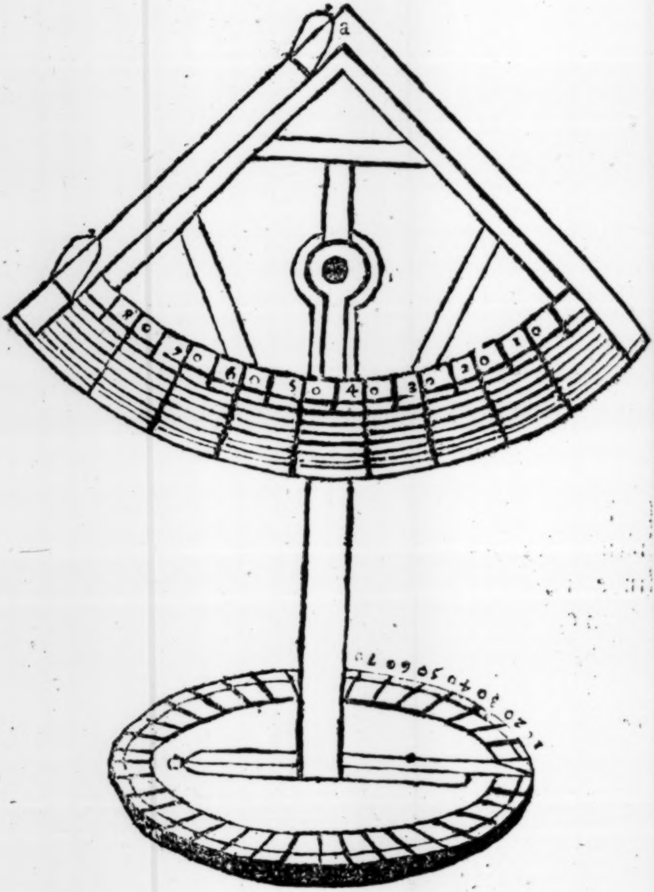
Alti-

Altitude.

III. The Altitude is the Arch of a Vertical Circle, accounted in the Sphere of the Phænomenon, contained between the Visible Horizon, and the apparent place of the Starr, such is the Arch, *b*, *c*, in the Figure before; But the Parallax or Difference of Aspect, is the Arch *e*, *d*, in the Eighth Sphere, and measureth the Angle *d*, *c*, *e*, and the Vertical thereof, *a*, *c*, *b*.

IV. The Distance from the Zenith is the Complement of the Altitude before mentioned, and is the Arch *c*, *g*.

V. In the next place it will be convenient to make an Instrument, wherewith to observe, that may take the Altitude and the Azimuth both together, wherein every man is left to his own Devise; yet I will pass my opinion thus; First let a round Stone polished (be it White Marble or the like) be setled Horizontally, this may be 2½ Foot Diameter, and on the Center



ter draw a Circle, and draw thereon al-
ſo a Meridian Line, and croſs it in the
Center at right Angles with a Line of
East

East and West, commonly called a Prime Vertical, divide each Quadrant thereof into 90 equall parts, and figure them from each end of the Meridian line, with 10, 20, 30, *&c.* to 90; And let it have a round Pin or Cylinder of Iron fixed Perpendicular in the Center; Also let a bearer for the Quadrant be made of convenient hight, with a hole in the lower end, to slip upon the Pin or Cylinder fastened in the Center of the Stone, and let the bearer also have a cross foot to stand upon the Stone to keep it Perpendicular thereto, one barre of the cross foot is to be continued out to the devided limb of the Stone, in form of a Diopter, running through the Center of the Stone, to shew the Azimuth. Upon the bearer fasten a Quadrant in the Center of Gravity of the Quadrant, and this Quadrant may be about 2½ foot Semidiameter (but the larger the better) with a broad limb to be devided into Sexagenarie or centesimal minutes with Diagonal lines, the Quadrant may have a Pin in the Center, *a*, whereon to hang a Thred & a Plummet, the Thred may be a small Steel Cittern string, and it will bear a round Plummet or Bullet of about two pound weight. *To*

To find the Altitude of the Pole by Observation.

VI. Becauſe in this caſe the Altitude of the Pole is neceſſary to be known to the neareſt, and that I ſuppoſe it cannot be found near enough by help of the Sun's Meridian Altitude, and Tables of his Declination, therefore I thought meet to ſhew how it may be done to the neareſt at the place where the Inſtrument is to be placed, thus; Take two Meridian Altitudes (*viz.* the higheſt and the loweſt) of ſome one of the Northern Stars, which ſetteth not, neither riſeth to the Zenith (ſuch may be ſome in the Tail of the *Great Bear*, or one of the Stars in *Caſſiopea*, for theſe may be obſerved in *December*, near ſix in the Morning; and ſix at Night) Subtract the loweſt Altitude from the higheſt, and take half the difference, and adde it to the loweſt Altitude to give the height of the Pole.

But

But in takeing the Altitude of any fixed Starr that is less then 20 *gs*. high, take the Refraction from the Altitude observed, to leave the true height, for the Refraction maketh the Starr to seem higher then indeed it is, as in *Ticho Brahe's* Table of the Refraction of fixed Starrs here following.

Alt.	*Refr.* ′ ″	*Alt.*	*Refr.*
0	30. 00		
1	21. 30	11	5. 00
2	15. 30	12	4. 30
3	12. 30	13	4. 00
4	11. 00	14	3. 30
5	10. 00	15	3. 00
6	9. 00	16	2. 30
7	8. 15	17	2. 00
8	6. 45	18	1. 15
9	6. 00	19	0. 30
10	5. 30	20	0. 00

Proportion between the Two Arches of Parallax.

VII. Seeing that in taking Parallax there is alwaies two observations to be made, and the summe or differ-rence

rence of the Two Parallaxes is expected thereby, it is therefore neceſſary, whether I have their ſumme or difference, to know what is the Proportion between them, that thereby they may be found ſeverally; Concerning this, read Dr. *John Dee*'s Third Theorem of his *Parallaticus Nucleus* which is.

In whatſoever two divers Parallaxes of the ſame Starr, or the like Phænomenon (ſo that in the mean time it be conceived to be carried only with the Diurnal motion of the whole) there will be the ſame reaſon, or proportion of the right ſine of the greater Parallax, to the right ſine of the leſſer, that is, of the right ſine of the greater apparent diſtance from the Vertex, to the right ſine of the leſſer apparent diſtance, from the Vertex.

This is as plainly demonſtratedby the Authour, as it is ſpoken.

To

To Separate the Arches of Parallax, when the ſumme of them is given.

VIII. If the ſumme of Two Arches of Parallax be given in one Arch, then they may be ſeparated, by help of the Sixt Propoſition of *Clavius*'s *Triangula Rectilinea,* thus; Take the natural ſines of the two diſtances of the Starr from the Zenith (for they are in the ſame Proportion with the ſines of the Two Parallaxes, as in the laſt Note) Adde theſe two ſines together, and take half their ſumme; Alſo take the ſine of the leſſer diſtance from the Zenith, from the ſaid half ſumme to have their difference, and then the proportion is,

As the ſaid half ſumme of the ſines of the diſtance from the Zenith,
Is to the Tangent of the half ſumme of Parallax
So is the difference aforeſaid
To the Tangent of another Arch.

Which

Which Arch being added to the half ſumme of the Parallaxes, giveth the greater Parallax, and being ſubtracted from the half ſumme of the Parallaxes, leaveth the leſſer Parallax.

But if the Difference of Two Parallaxes be given.

IX. Then ſeeing the ſines of the Diſtances from the Zenith of the Starr, is the termes of Proportion between the two unknown Parallaxes thereof, as by he 7th. Note, thereforee take the natural ſines of the ſaid diſtances, and ſubtract the leſſer ſine from the greater, and take half the difference for the Firſt in the Rule of Three; alſo adde the ſame half difference to the leſſer ſine of diſtance from the Zenith, for the Third in the Rule of Three, and then the Proportion is,

As the half difference of the Two ſines from the Zenith,
To the Tangent of the half difference of the Parallaxes,
So is the Aggregate of the half difference

rence of the ſines aforeſaid, and the leſſer ſine of diſtance from the Zenith,
To the Tangent of an other Arch.

To which Arch adde half the difference of Parallaxes, it giveth the greater Arch of Parallax; But the half difference of Parallax ſubtracted from the ſame Arch leaveth the leſſer Arch of Parallax. See *Clavius*'s 7th. Prop. of his *Triangula Rectilinea.*

Situation of a Comet.

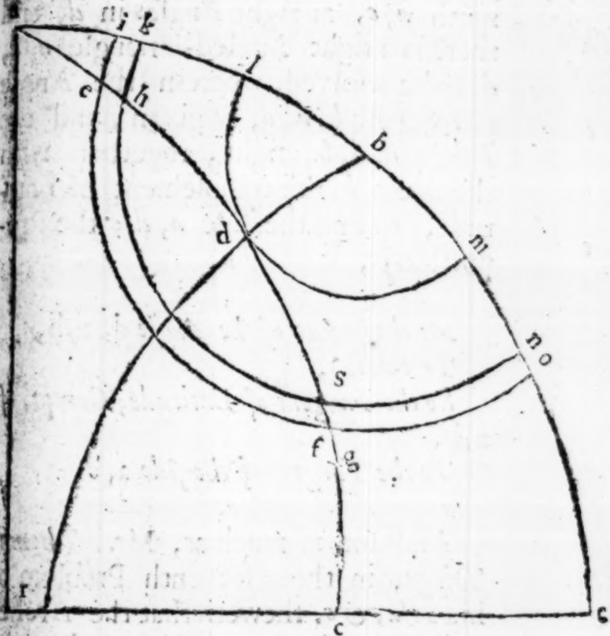
X. Concerning the Situation of a Comet, it may be ſo near the Pole, that it ſhall not ſet at the North, nor riſe ſo high as the Zenith; In this caſe to get the ſumme of the Parallaxes, ſubtract the leſſer Meridional diſtance from the Pole (which is alwaies that which is at his greateſt Altitude) from the greateſt Meridional diſtance from the Pole (to be found at his leſſer Altitude) and the remaine is the ſumme of the Parallaxes. See the Demonſtration hereof, in the Tenth Problem of Mr. *Thomas Diggs* his *Ala, ſeu Scala Mathematica.*

Now

Now having the summe of the Parallaxes, they may be separated and known by the 8th. Note before.

XI. But if the Phænomenon rise to the Zenith, then the Complement of the Latitude taken from the Meridional distance of the same, from or below the Pole, is the Parallax. But if the Phænomenon doe not set at the North, and yet cometh up beyond the Zenith toward the South, then the difference of the several Meridional distances from the Pole, is the difference of Parallaxes. Corollarie the Second of the same Tenth Problem of Mr. *Tho. Diggs*, his *Ala*, *&c.* And then the several Parallaxes may be found by the 9th. Note before going.

XII. Moreover, seeing a Starr that setteth not at the North, nor riseth to the Zenith, Two Meridian Altitudes thereof (the higher and the lower) cannot be observed in one night except the right Ascension thereof, and the right Ascension of the sunne doe differ near about 90 Degrees, therefore it will

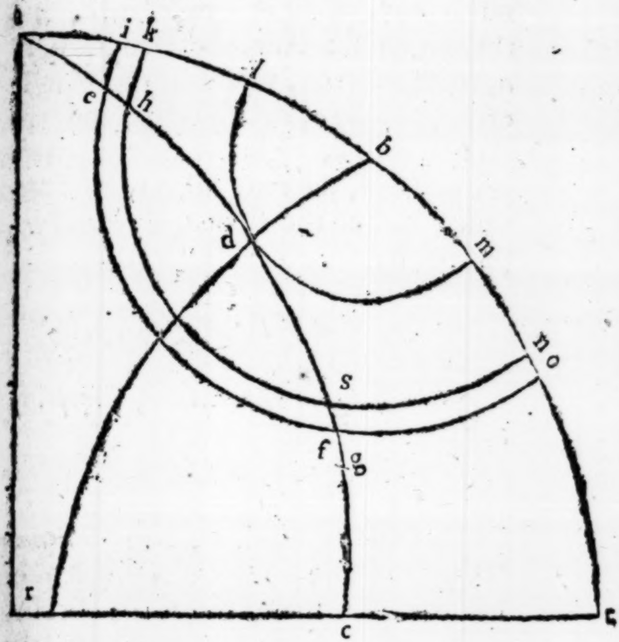


will be neceſſary to take two Altitudes thereof, *viz.* the higheſt and loweſt, in one and the ſame Azimuth Circle, as in the Figure above, wherein *a*, *b*, *t*, is the Merid. *r*, *c*, *t*, the Horizon, *a*, the Zenith *b*, the Pole of the World, *a*, *c*, the Azim. given, in which *h*, *g*, do ſhew the apparent places of the Starr, now the two parallels *i*, *o*, of true motion, and *k*, *n*, being drawn, draw alſo from the Pole *b* a

great Circle *b*, *d*, *r*, to cut the Azimuth *a*, *c*, at right Angles in *d*, and there is a right Angled-Triangle *a*, *b*, *d*, to be resolved, wherein the Angle of Azimuth *b*, *a*, *d*, is given, and the Angle *a*, *d*, *b*, right, together with the side *a*, *b*, the complement of Latitude, to find the side *a*, *d*; the Proportion is,

As the Cosine of the Angle d, a, b,
To Radius,
So the Tangent of Latitude, Compt. of a, b,
To the Tangent of the side a, d.

And for as much as, Mr. *Thomas Diggs*, in the Eleaventh Problem of his *Ala, &c.* sheweth that the Arches *e*, *h*, and *s*, *f*, are equal, and that the Arch *h*, *d*, is equal to the Arch *d*, *s*, Therefore the practice is this, Take *a*, *h*, the distance from the Zenith at the highest Observation, from *a*, *d*, the side of the Triangle found, then *h*, *d*, = to *d*, *s*, added to *c*, *g*, the lowest Altitude, and the summe subtracted from *d*, *c*, the Complement of the side *a*, *d*, leaveth *s*, *g*, the summe or Aggregate of the Two Parallaxes. And these may be separated by the Eighth Note. *If*



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great Circle *b, d, r,* to cut the Azimuth *a, c,* at right Angles in *d,* and there is a right Angled-Triangle *a, b, d,* to be resolved, wherein the Angle of Azimuth *b, a, d,* is given, and the Angle *a, d, b,* right, together with the side *a, b,* the complement of Latitude, to find the side *a, d*; the Proportion is,

As the Cosine of the Angle d, a, b,
To Radius,
So the Tangent of Latitude, Compt. of a, b,
To the Tangent of the side a, d.

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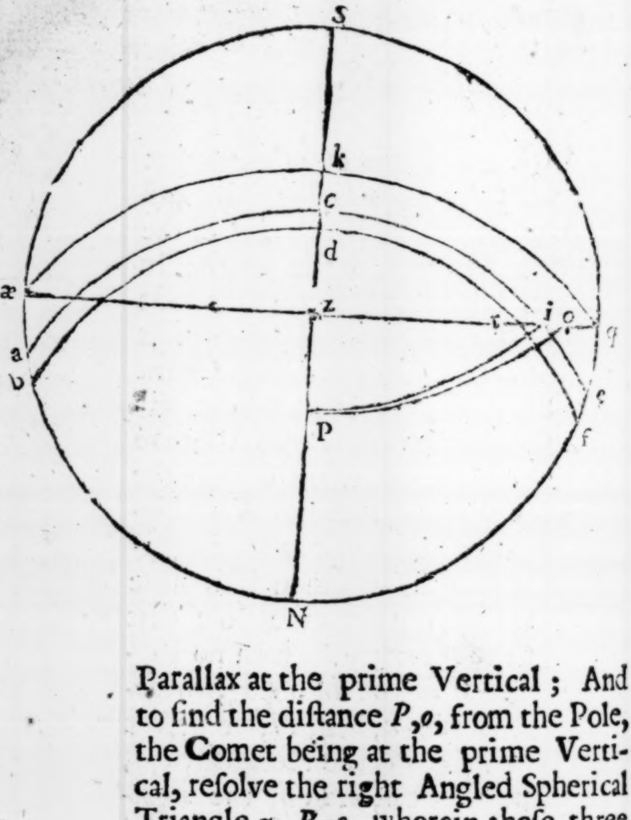
If the Comet doth Rise and Set.

XIII. Hitherto of a Comet that Setteth not, but ſuch as doe Riſe and Set, come not to the North part of the Meridian, but only to the South; In this caſe, Take the Meridian Altitude thereof, and adde the diſtance of it from the Zenith, to the Complement of Latitude to give the apparent diſtance thereof from the Pole; Alſo take the Altitude thereof when it is in the prime Vertical, or Eaſt and Weſt Circle,(if it move between the Equinoctial and the Zenith) and then if it have the ſame diſtance from the Pole that it had at the Meridian, it hath no Parallax, as in the Figure following, wherein let the Circle *a*, *S*, *q*, *N*, repreſent the Horizon, *S*, *N*, the Meridian, *a*,*q*, the prime Vertical, *a*, *k*, *q*, the Equinoctiall, *a*, *c*, *e*, the Circle or Parallel of apparent motion, it being at the Meridian, *b*, *d*, *f*, the Circle or parallel of true motion, *z*, the Zenith, *P*, the Pole of the world, *c*, *d*, the Arch of Parallax at the Meridian, *r*, *o*, the Arch of Par-



Parallax at the prime Vertical ; And to find the diſtance *P*,*o*, from the Pole, the Comet being at the prime Vertical, reſolve the right Angled Spherical Triangle *z*, *P*, *o*, wherein theſe three parts are given, Firſt *z*, *o*, the diſtance from the Zenith, Secondly the right Angle at *z*, Thirdly the Arch *z*, *P*, the Complement of Latitude, to find the Arch *P*, *o*, if this be equal to *P*, *c*, (for leſſer

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Parallax at the prime Vertical; And to find the distance *P*,*o*, from the Pole, the Comet being at the prime Vertical, resolve the right Angled Spherical Triangle *z*, *P*, *o*, wherein these three parts are given, First *z*, *o*, the distance from the Zenith, Secondly the right Angle at *z*, Thirdly the Arch *z*, *P*, the Complement of Latitude, to find the Arch *P*, *o*, if this be equal to *P*, *c*, (for lesser

lesser it cannot be) then there is no Parallax, but if it be greater, then there is a Parallax; which to find, Resolve the right Angled Spherical Triangle *P*, *z*, *i*, wherein these Three parts are given, First the right Angle at *z*. Secondly the side *z*, *P*, Complement of Latitude, Thirdly the Arch *P*, *i*, = to *P*, *c*. the distance from the Pole at the Meridian, to find the side *z*, *i*, which if it be less then the observed Arch *z*, *o*, the distance from the Zenith, in the prime Vertical, then the difference is also the difference of Parallaxes. To Resolve this Triangle, the Proport. is,

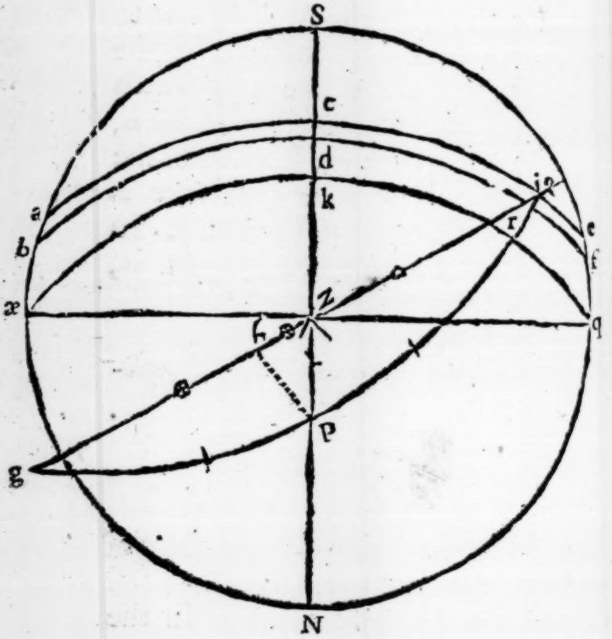
As Radius,
To the sine of Latitude, being Complement of z, P,
So Cosine of P, i,
To Cosine of z, i.

Thus having found the difference of Parallax *i*, *o*, the Parallaxes *d*, *c*, and *r*, *o*, may be severally found as in the Ninth Note.

If the Comet be under, or below the Equinoctial.

XIV

XIV. But if the Comet be on the South side of the Equinoctial, then as in the Figure following, Draw the Circle representing the Horizon, *S*, *N*, the Meridian, *a*, *q*, the prime Vertical, *a*, *k*, *q*, the Equinoctial, *a*, *c*, *e*, the



parallel of apparent motion (being at the Meridian) *b*, *d*, *f*, the parallel of true motion, *z*, the Zenith, *P*, the Pole of the world, *c*, *d*, the Arch of Parallax

lesser it cannot be) then there is no Parallax, but if it be greater, then there is a Parallax; which to find, Resolve the right Angled Spherical Triangle *P*, *z*, *i*, wherein these Three parts are given, First the right Angle at *z*. Secondly the side *z*, *P*, Complement of Latitude, Thirdly the Arch *P*, *i*, = to *P*, *c*. the distance from the Pole at the Meridian, to find the side *z*, *i*, which if it be less then the observed Arch *z*, *o*, the distance from the Zenith, in the prime Vertical, then the difference is also the difference of Parallaxes. To Resolve this Triangle, the Proport. is,

As Radius,
To the sine of Latitude, being Complement of z, P,
So Cosine of P, i,
To Cosine of z, i.

Thus having found the difference of Parallax *i*, *o*, the Parallaxes *d*, *c*, and *r*, *o*, may be severally found as in the Ninth Note.

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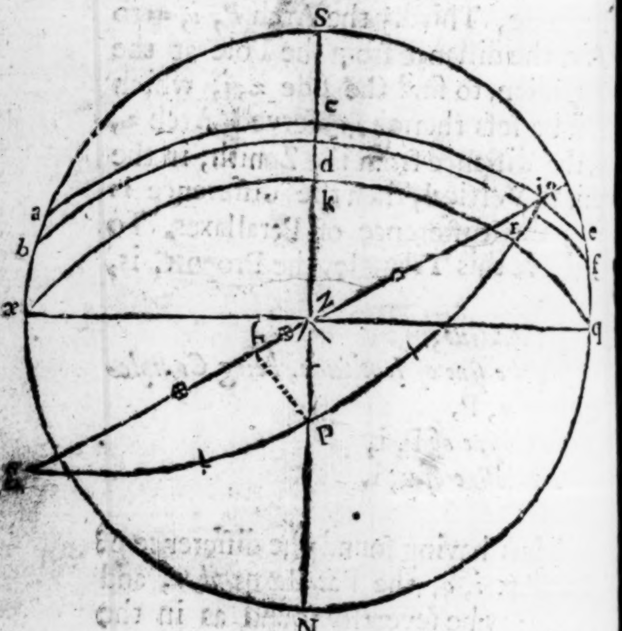

parallel of apparent motion (being at the Meridian) *b*, *d*, *f*, the parallel of true motion, *z*, the Zenith, *P*, the Pole of the world, *c*, *d*, the Arch of Paral-

at the Meridian, *r*, *o*, the Arch of Parallax to be taken on some Azimuth; and then Resolve the Oblique Spherical Triangle *z*,*P*,*i*; in doin of which, continue forth the sides *z*,*i*, and *P*,*i*, to semi-circles, and the Perpendicular *P*, falleth without the Triangle given, therefore resolve, the Triangle *z*,*g*,*P*, wherein first to get the side *z*,*h*, of the Triangle *z*,*P*,*h*, The Proportion is,

As Radius,
To the Cosine of the Angle P,z,h, the Azimuth,
So the Tangent of the hypotenusal z,P,
To the Tangent of the side z, h.

Which being had, get also the side *g*, of the Triangle *g*,*h*,*P*, the Propor. is,

As the Cosine of z, P,
To the Cosine of g, P,
So the Cosine of z, h,
To the Cosine of g, h.

Which Two Arches *g*,*h*, and *h*,*z*, being added together, and taken from a semicircle, leaveth the Arch *z*,*i*, which if it be lesser then the Arch *z*,*o*, then is the difference of Parallaxes, & then by the 9th. each may be found.

XV. This being understood, the Angle of Parallax may be found, at any one

one place of the Earth, and in any situation of the Comet; And the desired distances from the Earth may be calculated, as in the Triangle *a,b,c,* in the first Figure; wherein adde 90 *gs* to the Angle of Altitude above the Horizon, to give the Angle *a,b,c,* at the Eie, to this adde the Angle of Parallax *a,c,b,* and subtract the aggregtae from 180*gs*, it leaveth the Angle *b,a,c,* at the Center of the Earth. And then the proportion is alwaies.

For the distance from the Eie,

As the sine of the Angle of Parallax a,c,b,
To one Semidiameter a,b,
So is the sine of the Angle at the Center b,a,c,
To the distance b,c, *in Semidiameters of the Earth.*

For the distance from the Center of the Earth.

As the sine of the Angle of Parallax a,c,b,
To one Semidiameter a, b,
So is the sine of the Angle a,b,c,
To the distance a, c, in Semidiameters of the Earth.

These Semidiameters of distance, may be turned into Miles if you multiply them by $3436\frac{4}{11}$.

FINIS.